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but we must provide a suitable atmosphere for our investigators. It seems to me that certain conditions, which are necessary to make a good atmosphere, are, as yet, lacking in many institutions. Probably the most serious defect in our anatomical departments is due to the appointment of men in active medical practise to the chairs of anatomy. Unlike professional anatomists, they rarely have the time to devote to teaching students, nor the requisite training to enable them to develop the department properly, and anatomy necessarily suffers. However, I regard it as fortunate that circumstances have placed us in a position from which there is no retreat. To carry on the campaign, now so well started, we must have many more productive anatomists. In order to obtain them and to make the efforts of our present investigators more effective, we must use all our influence to bring the greatest opportunities and the best men together. A highly cultured community naturally desires the ablest man. My earnest hope is that those in authority in various communities will recognize that our idea of the scope of anatomy is correct, and that they will seek productive anatomists, when vacancies occur, so that our grand science may be raised to the level it has always held in Europe.

FRANKLIN P. MALL

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
SOME PHASES OF PREHISTORIC
ARCHEOLOGY¹

THE American field for anthropological research is so wide and so fertile that it not only monopolizes the attention of specialists at home, but also attracts to our shores numerous foreign investigators. For attestation of this fact, one has but to cite

¹ Address of the vice-president and chairman of Section H—Anthropology—at the New York meeting of the American Association for the Advancement of Science.

the fourteenth International Congress of Americanists held in the city of Quebec last September. The same congress had convened in the new world twice before, once in New York City and once in the City of Mexico, the remaining sessions having been held in various European cities.

When foreign savants take such a deep interest in our own problems it is fitting that we should reciprocate by at least an occasional survey of the foreign field. In looking over the list of vice-presidential addresses read before this section, I find that two such surveys have already been made.² The address of Professor E. S. Morse, entitled 'Man in the Tertiaries,' was a powerful argument in favor of the existence of man's ancestors in Tertiary times. Fifteen years later Dr. Thomas Wilson chose for his subject, 'The Beginnings of Prehistoric Anthropology.'³ He not only had something to say about Tertiary man, but also covered the paleolithic and neolithic periods. In the more than seven years that have elapsed since Dr. Wilson's address was read, much progress has been made in the prehistoric archeology of Europe. This is especially true concerning our knowledge of the *colithic question* and of *paleolithic art* in so far as it has to do with engravings and frescoes on certain cavern walls. In fact, coliths and paleolithic mural decorations were not even mentioned by Dr. Wilson. He did refer, however, to Harrison's discoveries of 'paleoliths' on the Chalk Plateau of Kent, but confused these with the well-known river-drift implements.

THE EOLITHIC PERIOD

When Thomsen published his relative chronology for prehistoric times in 1836,

² Vice-presidential address, *Proc. A. A. A. S.*, 1884, XXXIII., 579.

³ Vice-presidential address, *Proc. A. A. A. S.*, 1899, XLVIII., 309.

the only stone age known was that which is now called the neolithic period. Boucher de Perthes's first discovery of paleoliths in the river drift of the valley of the Somme came just two years later. These river-drift implements, however, were not accepted until after (Sir) Joseph Prestwich's visit to Abbeville in 1859.

Is there a stone industry antedating the paleolithic? The answer depends in a measure upon the definition of the term. The Chellean *coup de poing* is quite generally looked upon as representing the oldest paleolithic industry. As to its position in the geological scale opinions differ. Piette and de Mortillet placed it in the Lower Quaternary. According to the more recent classifications of Rutot and Boule, the Chellean belongs to the Middle Quaternary. If the latter view is correct, then a pre-Chellean industry need not necessarily be of Tertiary age. The presence of artifacts in the Lower Quaternary should not be surprising even to the most sceptical. This is particularly true in view of the fact that the well-known almond-shaped implement represents an advanced stage in the art of chipping flint. While Professor M. Boule does not doubt that industrial remains may exist in the Lower Quaternary and even in the Tertiary, he denies that they have as yet been discovered. In his own words as a paleontologist he has a firm faith in the existence of Tertiary man, traces of whom he believes will some day be found. On the other hand, Dr. A. Rutot accepts as man's handiwork the rudely chipped specimens not only from the Lower Quaternary, but also from the Pliocene and Upper Miocene.

The first serious claim for the existence of a Tertiary industry was made by the Abbé Bourgeois in 1867. The subject at once attracted considerable attention; but after a lively discussion that lasted for five or six years it was relegated to the

background. The specimens that Bourgeois found in the Upper Oligocene at Thenay are not at present accepted as artifacts.

Carlos Ribeiro's discovery of chipped flints in the Upper Miocene and Lower Pliocene at Otta and other localities near Lisbon was announced in 1871. An account of Delgado's researches at Otta was published in 1889. Professor Verworn,⁴ who recently visited this locality, is of the opinion that the deposits there have been so disturbed as to make the age of the artifacts doubtful. They may be paleolithic and even neolithic.

The problem is simpler at the classic stations near Aurillac (Cantal). The best known of these are at Puy-Courny and Puy-Boudieu. Here the deposit in question is of Upper Miocene age, fossiliferous and undisturbed. It is covered by a bed of andesitic tufa that attains in places a thickness of from sixty to one hundred meters. There is no doubt as to the geological age of the chipped flints. As to the nature of the chipping, however, opinions differ.

When attention was called to the first specimens discovered by Rames in 1877, such well-known authorities as de Mortillet, Cartailhac, Chantre, de Quatrefages and Capellini declared that if these flints had been found in Quaternary deposits, no one would hesitate to regard them as artifacts. The Cantal industry has been carefully studied in more recent years by Capitan, Rutot, Courty, Klaatsch and Verworn, all of whom have decided in favor of its genuineness.

The revival of interest in a pre-paleolithic industry in England began when Mr. Benjamin Harrison, of Ightham, Kent, who had been collecting paleoliths from the

⁴Max Verworn, 'Archäolithische und paläolithische Reisestudien in Frankreich und Portugal,' *Zeit. für Ethnol.*, 1906, S. 611.

river drift of the neighborhood for years, extended his field of search in 1885 to include the summit of that portion of the chalk plateau which lies between the valley of the Darent on the west and that of the Medway on the east. Here at heights of from four hundred to seven hundred feet above the sea, he discovered flints supposed to have been chipped by the hand of man.

As Harrison's collection grew it was submitted to Sir Joseph Prestwich, whose country-seat was at Shoreham in the Darent Valley near by. Thirty years earlier Prestwich had confirmed the accuracy of Boucher de Perthes's discoveries in the valley of the Somme. Who could be better fitted than he to answer the questions as to the age of the specimens and of the southern drift in which they occur, as well as to the character of the chipping. According to Prestwich the rudely chipped flints are artifacts and are as old as the southern drift. They are both older than the northern drift or boulder clay, and hence preglacial. Rutot places them in the Middle Pliocene. The southern drift (with implements) was transported across the chalk escarpment and the chalk plain into the Thames Valley along lines independent of the present drainage; the patches that are now left on the highest points (eight hundred and sixty-four feet at Titsey hill west of the Darent Valley), marking what were then the valleys.

Mr. J. Allen Brown,⁵ in discussing the specimens found on the North Downs by Harrison, was the first to propose the term 'eolithic,' now so much in evidence. Two years later, G. de Mortillet made use of the term in his 'Classification palethnologique,'⁶ applying it to the Tertiary only. Dr. Rutot⁷ does not limit the eolithic

period to the Tertiary. In his classification, as previously stated, the early phases of the Quaternary are also eolithic, the well-known hache type (Chellean) not appearing until the second advance of the ice.

Eoliths are by no means confined to Kent. They have been found by Shrubsole in Berkshire; by Blackmore, Bullen and others near Salisbury, Wilts; at Dewlish in Dorset; also in Surrey, Hampshire, the southern part of Essex and Norfolk. Mr. Percival A. B. Martin has found eoliths at a number of places on the South Downs in the neighborhood of Eastbourne and Beachy Head.

Are eoliths artifacts? This is the fateful question. Their geological age is of no consequence if they are only natural forms and have never been used by man or his precursor. The first flakes to be utilized were in all probability natural forms. It is not likely that eolithic man knew how to obtain the raw material from the chalk. He depended on picking up from the drift flakes of approximately the shape and size needed. A sharp edge was utilized once, twice, or until it became dulled, and was then cast aside. If an angular piece did not admit of being comfortably grasped in the hand, the troublesome corners were removed. Such conclusions as these are forced upon one after careful examination of a series of the specimens in question. Would the same conclusions be so irresistible if these objects were merely nature's playthings? Many may even be grouped according to more or less definite patterns. Two of these deserve special mention, viz., the small crescent-shaped scrapers comparable to the spoke-shave, and the double scrapers with an intervening point between the two scraping edges. Sometimes two margins are worked, but on opposite sides. That is to say, after chipping one of the margins, instead of rotating the specimen

⁵ *Jour. Anthr. Inst.*, March 8, 1892, XII., 93-94.

⁶ *Bull. Soc. belge de géol., de paleon. et d'hydrol.*, Bruxelles, 1903, XVII., 425.

⁷ *Bull. Soc. d'Anthr. de Paris*, 1894, p. 616.

until the adjacent margin comes into play, it was reversed.

Belgian archeologists were among the first contributors to our knowledge of a pre-Chellean industry. The discoveries by Neyrinckx in the railway cut at Mesvin, between Mons and Harmignies, date from 1868. M. Emile Delvaux later took up the work at Mesvin, where he succeeded in determining the presence of a rude industry antedating the paleolithic, to which he gave the name Mesvinian. During the past twenty years, Belgium's most indefatigable worker in the prehistoric field has been Dr. Rutot, his studies being confined chiefly to the Quaternary deposits.

The river valleys of Belgium are often marked by three terraces: the upper terrace, of Pliocene age, about ninety meters above the present water-level; the middle terrace, at an elevation of from twenty-five to sixty-five meters, and the lower terrace, a little above high-water-level, both of Quaternary age. The Quaternary may be divided into five series of deposits. Beginning with the oldest, these are: (1) Mosean, (2) Campinian, (3) Hesbayan, (4) Brabantian, (5) Flandrian. These deposits have been carefully examined by Rutot in quest of industrial remains.

With the exception of the Brabantian, which is above the eolithic zone, all five divisions of the Quaternary are represented in section in the exploitation Helin at Spiennes, near Mons, phosphate works now owned by the Société de Saint-Gobain. All of the Quaternary eolithic epochs are likewise represented here with the exception of the oldest, the Reutelien. Rutot found that the three separated industry-bearing Campinian layers each furnished one of the several elements composing the industry previously found elsewhere in disturbed Campinian deposits. In the lowest of the three, there were not only eoliths of Mesvinian age, but also rude

implements roughly amygdaloid in shape, selected flint nodules only slightly chipped to a semblance of the hache type, or poniard. All the requirements of a transition industry between the Mesvinian (eolithic) and the Chellean (paleolithic) are therefore satisfied. The middle layer furnished examples of the classic *coup de poing*; and in the uppermost layer there were specimens of the hache type, carefully chipped on both sides until the margins presented almost a straight line as opposed to the zigzag margin of the Chellean implement—in other words, the so-called Acheulian industry of M. d'Ault du Mesnil. Rutot has proposed the name Strépyan for the industry of transition from the eolithic to the paleolithic because of the character and abundance of the specimens found at Strépy, on the right bank of the Haine, between Estinnes and Cronfestu.

Following Rutot's lead, many German investigators have taken up the search for a pre-paleolithic industry in northern Germany, particularly in the valleys of the Elbe and Spree and on the Island of Rügen. The chief contributors have been Professors H. Klaatsch, Eugene Bracht and Max Verworn and Drs. Hans Hahne, G. Schweinfurth,⁸ Eduard Krause, *et al.*

For some years past, the spread of the eolithic propaganda has been so rapid as to cause dismay in the camp of its opponents. I spent the summer of 1903 in England and Belgium for the express purpose of studying the question at closer range. That summer's work formed the basis for a preliminary report⁹ read at the St. Louis meeting of the American Association at the close of the same year, as well as for a more extended paper¹⁰ published.

⁸ Schweinfurth's studies have been confined chiefly to Egypt.

⁹ SCIENCE, 1904, p. 449.

¹⁰ 'The Eolithic Problem—Evidences of a Rude Industry Antedating the Paleolithic,' *Amer. Anthropol.*, N. S., VII., 425-479.

lished in 1905. Before the latter was out of press there appeared an article by Professor Boule,¹¹ intended as a severe blow to the genuineness of eoliths. He had been trying for twenty years to stem the rising tide in favor of a pre-paleolithic industry and was beginning to think of instituting experiments in the hope of throwing light on the origin of eoliths, when M. A. Laville, preparator at the École des Mines, Paris, found an experiment station already in working order and turning out 'eoliths' daily by the hundreds. It was a cement factory on the left bank of the Seine, two kilometers southeast of Mantes, near Paris.

In extracting the chalk from the quarry most of the flint nodules are cast aside. Some, however, pass unnoticed by the workmen and are carried with the chalk to the factory. This, together with a certain amount of clay, is emptied into circular basins (*délayeurs*) or diluters. These vats have a diameter of about five meters and a depth of 1.4 meters. The water is supplied by means of conduits and finally escapes through lateral sieves, carrying with it the mixture of chalk and clay, both highly pulverized.

Each circular vat is provided with a horizontal wheel, the spokes of which are armed with cast-iron teeth that reach to within two tenths meter of the bottom, the wheel itself being just above the surface of the mixture. This wheel, with a diameter of five meters and making sixteen revolutions a minute, attains a velocity at the circumference of about four meters a second.

In this whirlpool of moving water, chalk, clay and iron teeth, are also the flint nodules that escaped the notice of the quarrymen. These nodules, therefore, receive thousands of knocks, some mutual, some

from the iron teeth, until at the end of a period of twenty-nine hours the machinery is stopped and they are removed. They are then washed and piled up to await their ultimate use as a by-product. It was in one of these piles that M. Laville's¹² discovery was made. Later he visited the place in company with MM. Boule, E. Cartailhac and H. Obermaier.

According to Boule, the flints that have passed through the machine have all the characters of the ancient river gravels. Most of them have become rounded pebbles. Many, however, are chipped in a manner to resemble a true artifact. He and his companions were able in a few minutes to make a 'superb collection, including the most characteristic forms of eoliths, hammer-stones, scrapers, spoke-shaves,' etc. His article is illustrated by half-tone figures, which, however, are of very little use to the reader. Photographs of eoliths are practically useless; faithfully executed line drawings are little better; a view of the objects themselves is absolutely necessary before passing judgment on their origin.

Professor Boule does not pretend that all eoliths have a natural origin more or less analogous to those made by machinery. He does claim 'that it is often impossible to distinguish between intentional rudimentary chipping and that due to natural causes.' In his opinion, the artificial dynamics of the cement factory are comparable in every respect to the dynamic action of a natural torrent.

Nothing is really gained even by proving the impossibility of distinguishing between man's work and chipping due to natural causes. If the argument is worth anything it will admit of a still wider application because of the fact that it is admittedly impossible to distinguish between certain true eoliths and some artifacts of the paleolithic and neolithic periods. Things that

¹¹ "L'Origine des éolithes," *L'Anthropologie*, t. XVI.

¹² "Feuille des jeunes naturalistes," 1905, p. 119.

are equal to the same thing are equal to each other. By substituting, therefore, one arrives at the identity between stream-made and machine-made eoliths, on the one hand, and recognized artifacts, on the other. This does not prove the non-existence of true eoliths any more than it does that of the paleolithic or neolithic artifacts.

If streams at flood ever produced eoliths it is more than probable that they may still be doing so. While keeping one eye on the chalk-mill at Mantes might it not be well to keep the other on the Seine that flows near by? A few Seine-made eoliths would certainly be more convincing than those turned out at the factory.

It has not been my good fortune to see one of those cement factories at work. It is evident from the available literature on the subject that considerable prejudice has entered into the controversy. MM. Laville, Boule, *et al.*, were evidently seeking for what they claim to have found at Mantes. On the other hand, it was extremely unfortunate that certain believers in an eolithic industry were refused admittance into the Mantes establishment. A selected series, however, from Mantes, which was sent in 1905 to the Salzburg meeting of the German Anthropological Association by Herr Obermaier, was later placed at the disposal of Professor Verworn and Dr. Hahne. Verworn compared them with his collection of eoliths from Cantal, while Hahne compared the Mantes specimens with a similar series from a chalk-mill on the Island of Rügen, and the eoliths from Belgium sent to him by Rutot.

Dr. Rutot has sought to match his superb collection of eoliths in the Royal Museum of Natural History, Brussels, with specimens from the chalk-mills of Belgium, but in vain. Professor Verworn and Dr. Hahne have been no more successful in their comparative studies. All three agree in their general conclusions as to the rad-

ical differences between the true and the false eoliths; also that the action of the mill is hardly comparable with that of the natural streams of the regions in question except in one particular, viz., both tend in time to make pebbles of the flints that are offered to them.

According to Professor Verworn,¹³ a fundamental difference exists between the eoliths he found at Puy-Boudieu and the pseudo-eoliths from Mantes. The corners and edges of the latter are worn, while those of the Cantal eoliths are not. It has been suggested that the chipping on the specimens from Puy-Boudieu may be due to pressure of the overlying beds. Such a result might be possible where unstable beds contained a sufficient quantity of flint nodules and chips pressing against each other. At Puy-Boudieu, however, the chipped flints are not resting against each other. They are separated by masses of tufa, loam and sand.

After a careful comparison of machine-made eoliths from both Mantes and Sassnitz with the Mafflean and Mesvinian industry from Belgium, Dr. Hahne's¹⁴ conclusions are as follows: (1) The chalk-mill flints are all scratched and otherwise marked by the iron teeth of the mill. (2) The sides of all the larger pieces are bedecked with scars from blows that were not properly placed to remove a flake. (3) Almost every piece shows more or less of the original chalky crust of the nodule. (4) Anything like a systematic chipping of an edge or margin is never found except for very short stretches where one would expect it to be carried along the entire margin. This is quite different from the long retouched margins of most eoliths. (5) The same edge is often rechipped first on one side and then on the other absolutely without

¹³ *Op. cit.*, p. 620.

¹⁴ 'Über die Beziehungen der Kreidemühlen zur Eolithenfrage,' *Zeit. für Ethnol.*, 1905, S. 1024.

meaning or purpose. The 'reverse working' of true eoliths is quite another thing. (6) In the mill product coarse chipping alternates with fine retouches along the same margin, while on the eolith there is a regularity and orderly sequence of chipping. (7) The repeated rechipping of the same edge, while others are left untouched, does not occur in machine-made eoliths. (8) The chief difference is between the haphazard and meaningless, on the one hand, and the purposeful, on the other.

The most prominent and easily breakable parts suffer most in passing through the mill. They are often retained intact, or only slightly altered, on the eolith to serve as a hand-hold, and there is a logical relationship between the worked and unworked portions.

The eolithic problem in northern Germany is even more difficult of solution than that of chalk-mill 'eoliths.' Dr. Klaatsch, who had previously made a study of eoliths in France and Belgium, was among the first to find so-called eoliths in fluvio-glacial deposits in the valley of the Spree. His discoveries were supplemented by Dr. Hahne's in the valley of the Elbe. At this latitude, the deposits of the first glacial and first interglacial period, containing what appears to be an eolithic as well as a transition (Strépyan) industry, were very much disturbed by the second advance of the ice.

The result is that the pieces in question are so badly damaged as to obscure the evidence bearing on their genuineness. The German geologists and anthropologists are divided as to the proper interpretation to place upon these specimens. After going over the material with Dr. Hahne, Rutot is of the opinion that after all doubtful pieces are rejected there will remain enough to establish the existence of an eolithic industry in those regions.

Another subject studied in common by Rutot¹⁵ and Hahne is that of shore-made

eoliths, the locality being a favored stretch of coast on the island of Rügen in the Baltic Sea. The chalk cliff is surmounted by a moraine with large erratic blocks. When the seas run high, the large blocks and glacial till are thrown forward over the cliff. Masses of the fissured chalk are also loosened and fall to the foot of the cliff. With recurring high seas, broken nodules of flint come in contact with the erratic blocks and the production of pseudo-eoliths begins. If left, however, to their own fate they are finally reduced to sand. When rescued at the proper time, they resemble more or less the true eolith. They certainly form a more convincing argument in favor of the natural origin of all eoliths than do those from the chalk-mills. But they resemble the latter more than they do the genuine eolith, which, according to Rutot and Hahne, is still unaccounted for unless it represents the handiwork of man or his precursor.

The differences are not great enough to be detected by the untrained eye. They may be compared to the differences between hand-made and machine-made music. The untrained ear might not detect them without seeing the operator at work, but no such substitution could deceive an expert. It would be rather wide of the mark to conclude that, because pianos may be played by a pianola, they were never played by hand. Or if ever played by hand the result must necessarily be identical with that produced by the pianola.

The wide differences of opinion in the opposing camps can hardly be due to prejudice alone. Faulty or insufficient observation and incorrect interpretation doubtless play their part. Luckily, there is no disposition to drop the matter until the truth appears. At the International Congress of Anthropology and Prehistoric Archeol-

¹⁵ 'Eolithes et pseudo-eolithes,' *Mém. de la Soc. d'anthrop. de Bruxelles*, 1906, t. XXV.

ogy held at Monaco, April 15 to 22, 1906, the chief subject of the second session was the pedigree of the eolith. According to *Nature*,¹⁶ "a series of mill-modeled flint nodules was exhibited, among which there were certainly a number closely resembling many Prestwichian types, but conspicuous by their absence were the decidedly purposeful and rationally usable Kentian forms." On the other hand, Professor E. Ray Lankester "submitted that he had recently placed on exhibition in the British Museum a considerable series¹⁷ of specimens selected from Prestwich's collection, all borer-like in form, too identical in shape and so rationally of obvious utility for any possibility of their being the result of fortuitous natural collisions."

As a further indication of the importance attaching to a correct solution of the problem and indirectly in recognition of the value of Rutot's contribution toward such a solution, the meeting of the German Anthropological Association for 1907 will be held in Cologne¹⁸ in order that the members may visit the eolithic stations of Belgium and see the collections of the Brussels Museum.

THE ART OF THE CAVE-DWELLER

Passing now from Tertiary and Lower Quaternary eoliths and leaving out of account for the time being the important industry of the Chellean and Mousterian epochs, we come upon a most interesting chapter in the history of paleolithic man—a chapter to which many attractive pages have been added during the past ten years. It concerns the art of the cave-dweller.

One of the earliest enlightened searchers for prehistoric man in caverns was the

¹⁶ June 28, 1906, p. 211.

¹⁷ *Amer. Anthropol.* (N. S.), 1905, VII., 432, 433.

¹⁸ It is proposed to make the Cologne Congress international. American anthropologists have been invited to take part.

Rev. J. MacEnery, a Roman Catholic priest, stationed at Torquay on the southern coast of England. As early as 1825 he found, in Kent's Cavern, flint implements definitely associated with the remains of the mammoth, rhinoceros and other extinct animals.

Then came, in 1833, the discoveries of Schmerling in the caverns about Liège, Belgium; but these also did not receive the attention they deserved, owing to the then all-powerful influence of Cuvier.

Following the appearance of Darwin's 'Origin of Species' and the acceptance of the river-drift implements as artifacts, both of which events occurred in 1859, cavern explorations received a new impetus. In Europe alone hundreds of paleolithic caverns have already been explored. About one third of these are situated in France. Some of the well-known localities outside of France are the regions about Namur and Liège, Belgium; Liguria in Italy; Moravia in Austria; and Schaffhausen in Switzerland.

To the student of the cave-dweller period, southern France is perhaps the most fruitful field in all Europe. Of this area Les Eyzies and its environs in the valley of the Vézère, department of Dordogne, is one of the chief centers. It was in 1862 that M. J. Charnet found in a shallow cave at Les Eyzies the first flint implements and breccia, with bones of the reindeer and other animals. He communicated the facts to Professor Eduard Lartet, of Paris, and Mr. Henry Christy, of London, who visited the place in August, 1863, making explorations simultaneously at Les Eyzies, Gorge d'Enfer and Laugerie-Haute.

This led, in 1865, to the plans for a great publication to be called 'Reliquiæ Aquitanicæ.' In importance, as well as in authorship, this is an international volume. The specimens described belong to the Christy collection of the British Museum

and to the Museum of National Antiquities at Saint-Germain. The Lartet and Christy explorations were practically confined to the rock shelters and shallow caves. If these men had lived longer, they might have discovered the extensive subterranean caverns of the neighborhood, the walls of which are decorated with a remarkable series of frescoes and engravings.

The valley of the Vézère has been an attractive field for archeological excursions ever since the appearance of Lartet and Christy's classic work; and has come even more into favor since 1895, when the first discovery was made of engravings and frescoes on the walls of one of the caverns. Several other caverns have been explored during the past six years with similar results. In company with a small party of Frenchmen from Paris, members of the Société des Excursions Scientifiques, I visited the region during the summer of 1903.

Vézère collections have found their way practically into all the important museums of the world, but the British Museum (Bloomsbury), the Natural History Museum, Paris, and the Museum of National Antiquities at Saint-Germain-en-Laye contain the major part. These should all be visited before, as well as after, a trip to the Dordogne. The train can be taken direct from Paris (Gare d'Orléans) to Périgueux, the capital of the department of Dordogne, the site of ancient Vesuna of the Petrocorii and later a flourishing Roman town. Here one may stop with profit to see the ruins of a Roman amphitheater and tower, also the Musée de Périgord, rich in prehistoric relics of Dordogne, including the Vézère region.

From Périgueux it is less than two hours by train to Les Eyzies, the heart of the cave-dweller country, where one stops at the Auberge Berthoumeyrou, well and favorably known to a long line of pilgrims to this enchanted land of limpid streams,

green valleys and lofty, picturesque escarpments.

The calcareous formation, cleft by the Vézère and its tributaries, is composed of Cretaceous beds approximately horizontal and of varying degrees of hardness; so that overhanging rocks often shelter horizontal galleries and niches. Again subterranean streams have left meandering caverns, some of them several hundred meters in length. These as well as the rock-shelters and open, shallow caves, formed through atmospheric agencies, were inhabited by early man. Some were enlarged or modified and occupied during the middle ages. At a safe height in the *roc de Tayac*, one such that withstood successive sieges in the fourteenth and fifteenth centuries is at present used as a restaurant and appropriately named 'au Paradis.'

The earlier explorations at Les Eyzies, Cro-Magnon, Gorge-d'Enfer, Laugerie-Basse, Laugerie-Haute, La Madeleine and Le Moustier are so well known that they are mentioned only in passing. After so long a series of important discoveries, it might well be supposed that the archeological possibilities of the region had been exhausted, yet some of the most important treasures still remained locked in the recesses of the less easily accessible and little known subterranean caverns which penetrate the hills to great depths. The entrances to these caverns are small and invisible from the valley below. Some, indeed, were completely stopped by hillside débris, leaving no outer trace of their existence. It is not strange that they escaped immediate notice. They were neglected until the early nineties, when Rivière removed some of the floor deposits in the cavern of Combarelles that yielded many flint implements, and especially fine bone needles. In 1895 he began work in similar deposits in the cavern of La Mouthe. One day, after penetrating to a considerable

depth, he and his companion, the son of Berthoumeyrou, the innkeeper, sat down to rest. In lighting a cigar, the extra light of the match added to the feeble candle light and placed at the proper angle revealed to one of them what had not been observed before—an engraving on the wall. The discovery was duly announced and marked the beginning of a new epoch in cavern explorations. Not that Rivière's discovery was the first of its kind; but that the two previous finds of a similar nature had not been accepted as authentic. These were in the cavern of Altamira, Province of Santander, Spain, explored in 1879 by Sautuola,¹⁹ and of Chabot (Gard), explored prior to 1889 by Léopold Chiron. Then followed Rivière's discovery at La Mouthe and that of Daleau in 1896 in the cavern of Pair-non-Pair (Gironde).

The mural decorations at La Mouthe occur in four groups or panels. The first panel is about ninety-three meters from the entrance. The second, four meters farther on, is called the 'Hall of the Bison.' Seven animals are represented on an area 5.02 m. by 2.6 m. The third and fourth panels are one hundred and thirteen and one hundred and thirty meters, respectively, from the entrance.

In 1899, Rivière was so fortunate as to find a stone lamp in the floor deposits of this cavern at a point about seventeen meters from the entrance. The pick of the workman broke the lamp into four pieces, of which three were immediately recovered. Rivière and two of his men searched for the missing fragment an entire day, but without success. The shallow bowl contained some carbonized matter, an analysis of which led M. Berthelot, the chemist, to conclude that lard was used for lighting purposes. On the base, there is an en-

graving of a wild goat's head and horns. A figure exactly like this was found on the third mural panel already mentioned. This was the fourth lamp to be found in French caverns. The first and second were from the cavern of Monthier (Charente), and the third from the cavern of Coual (Lot). The necessities of men dwelling in dark caverns would be likely to lead to the invention of artificial light, which light made it possible for them to depict the frescoes and engravings on the walls of their abodes.

The past six years have witnessed a succession of remarkable discoveries by MM. Capitan, Breuil, Bourrinet and Peyrony, in the caverns of Combarelles, Font-de-Gaume, Bernifal and others.

The Combarelles cavern has a total length of two hundred and thirty-four meters, is from one to two meters wide, and high enough to admit of walking upright for most of the way. The engravings begin at a point about one hundred and eighteen meters from the entrance, and occupy both walls for a distance of one hundred meters. Some of the figures are deeply incised; others are mere scratches. In some, the effect is heightened by the application of a dark coloring matter (oxide of manganese). Portions of the walls are covered by a coating of stalactite thick enough in places completely to hide engravings; while in others the more deeply incised figures are still visible. On areas devoid of incrustations, the figures are fresh and distinct. The artist sometimes had recourse to *champlevé*; sometimes natural prominences were utilized to add relief to the figures. Of the one hundred and nine engravings of various animals on the walls at Combarelles there are some forty equine figures, occurring either singly or in groups, and fourteen of the mammoth. The mural engravings belong precisely to the same school of art as the relief and incised figures

¹⁹ Don M. S. de Sautuola, 'Breves apuntes sobre algunos objetos prehistóricos de la provincia de Santander,' 1880, Libreria Murillo, Madrid.

from the floor deposits of the shallow caves and rock shelters, so well known through the works of the earlier investigators. This statement applies equally to all the caverns thus far explored.

The cavern of Bernifal was first explored in 1903. It was discovered by accident. The original entrance near the base of an escarpment is completely obstructed by earth and stones. The present artificial entrance is at a point where the ceiling of the cavern comes close to the surface of the wooded, sloping upland. The descent into the cavern is almost vertical, and made by means of an iron ladder about three meters long. There is a joint in the ladder, the upper portion of which may be inclined and locked so as to secure the interior against vandalism.²⁰ Within are three large chambers united by rather narrow corridors. The first is twenty-two meters long, with high ceiling and a maximum breadth of eight meters. The others are not quite so large. The beautiful stalactites overhead have been left undisturbed. Most of the engravings are to be found in the second chamber. They are cut rather deeply into the calcareous walls, and generally coated over with a thin, hard layer of stalactite. Twelve groups, numbering in all twenty-six figures, have been recognized. These include geometric, triangular signs, in addition to various animal figures—reindeer, mammoth, horse, bison and antelope. Some are simply engraved, others are painted with red ochre and manganese. Many are probably wholly hidden beneath thick mural incrustations. Tectiform signs, the significance of which is unknown, were also met with at Combarelles and Font-de-Gaume.

The Font-de-Gaume frescoes and en-

²⁰ Most of the prehistoric monuments of France are now the property of the government and are protected by the enactment and enforcement of wise laws.

gravings were discovered in 1901 by Capitan and Breuil with the assistance of M. Peyrony, the school principal of Lez Eyzies. The entrance is some twenty meters above the valley and near the top of the escarpment.

A passage about sixty-five meters long, and much restricted in places, leads to an ample gallery forty meters in length, two to three in breadth and five to six in height. A majority of the paintings, and Font-de-Gaume is especially rich in paintings, occur on the walls of this gallery and in a little side chamber farther on. The latter contains thirteen remarkable figures, in color, of the bison and a group of reindeer. The coloring matter was red ochre and manganese, either mixed so as to give various intermediate shades or used separately. Both these materials are found on top of the neighboring plateaus. The dimensions of the figures vary from 2.70 m. down to .20 m. Some are on regular surfaces, while others include natural prominences in such a way as to give the effect of relief. They are veritable frescoes, the whole figure often being covered with paint. Engraving and fresco are usually associated in the same figure. The coloring matter was, in some cases, applied after the engraving; while in others the process was reversed. Again some figures are a piece-work of engraving and fresco. Some are engraved only. In certain cases the outlines of the animal are simply traced by a single stroke of the brush or pencil, usually in black. Where the contours are filled in, various tints from black to red are usually employed. The outlines are seldom marred by blotches or evidences of an uncertain stroke.

Of the more than eighty figures described already from Font-de-Gaume, forty-nine represent the bison, four the reindeer, four the horse, three the antelope, two the mammoth, one the stag, one *Felis leo*, one *Rhi-*

noceros tichorhinus, six various signs. A number have not yet been determined.

In their various explorations MM. Capitan, Breuil and Peyrony have collected about a hundred drawings of the mammoth. Those of the bison, horse and reindeer are also numerous. On the other hand, representations of *Ursus*, *Felis* and *Rhinoceros* are rare. The engraving of *Ursus spelæus* on a piece of schist found in the floor deposits of the cavern of Massat (Ariège) has been known since 1867. A similar figure is to be seen on the cavern walls of Combarelles. An engraving of *Felis* on a pebble from the cavern of Gourden (Haute-Garonne) was recently published by Piette. Two mural engravings of *Felis* are known; one at Combarelles and the other at Font-de-Gaume. In the latter the entire animal is represented, being characterized by the form of the head, the general aspect of the body, the long, lifted tail and short paws. The animal is probably *Felis leo*, var. *spelæa*, since it is figured somewhat larger than are the four horses forming part of the same group or picture.

One of the most interesting animal representations on the cavern walls of Dordogne is a color drawing of *Rhinoceros tichorhinus*, found at Font-de-Gaume near the group that included an engraving of the cave lion. The figure is not only complete, but also exact. The two horns are faithfully indicated, the anterior notably longer and larger than the posterior. The only other representation of the woolly rhinoceros is an indifferent engraving on a piece of stone found in the cavern of Gourdan and recently published by Piette.

The cavern of Font-de-Gaume opens on a narrow valley tributary to that of the Beune and near their junction. The well-known rock shelter of Les Eyzies lies across the valley of the Beune. It is visible from Font-de-Gaume, appearing like a black spot

on the face of the great escarpment, and only eight hundred meters distant. M. Peyrony²¹ suggests that the two prehistoric communities may have been closely united. His recent researches at Les Eyzies tend to confirm this view.

The shallow cave of Les Eyzies, overlooking the Beune near its junction with the Vézère, opens on a sort of natural platform about thirty-five meters above the bed of the stream. The opening of the cave is wide and high enough to admit the light to its greatest depth, which is twelve meters. The greatest width is sixteen meters. It has a southern exposure; is dry and habitable. Font-de-Gaume was never a place of residence, as is indicated by the absence of floor deposits. About the only objects found there are a few broken graters with edges dulled in executing the wall engravings, a few pieces of ochre and manganese and one handsome ochre pencil. Why should the artists make residence of a dark subterranean cavern, when by going a short distance they could have an ample shallow cave or rock shelter facing the south and warmed and lighted by the sun? Such a shelter is Les Eyzies, and the enormous quantities of refuse taken from its floor at various periods testify to its use as a place of habitation by generation after generation.

The rock shelter of Les Eyzies has furnished unusually large quantities of ochre of various tints. Most of the pieces have been scraped to produce a colored powder which was mixed with grease or some liquid, thus forming a paint. In order to pulverize and thoroughly mix the coloring matter, mortars were used. An interesting series of these mortars from Les Eyzies

²¹ Le Dr. Capitan, l'Abbé Breuil et Peyrony, 'Nouvelles observations sur la grotte des Eyzies et ses relations avec celles de Font-de-Gaume,' *Compte rendu, Congrès préh. de France*, 1905, p. 137.

forms a part of the famous Christy collection in the British Museum. Very few mortars have been found in neighboring stations. Besides, ochre pencils exactly like the one from Font-de-Gaume have been found in the rock shelter of Les Eyzies. Sometimes a flat piece of ochre is cut in the form of a triangle, each angle serving in turn as a pencil point. Some of these pencils are perforated to be suspended, and might well be supposed to form a part of the outfit of the artists who drew in color figures such as that of the two-horned rhinoceros previously mentioned.

It may be that the artists who made their home at Les Eyzies decorated its walls also. Exposure would have obliterated these decorations long ago. Lucky it was for present-day lovers of art and archeology that their troglodyte forebears had the good sense to seek at Font-de-Gaume a more permanent gallery for their masterpieces.

In addition to the four caverns with wall engravings and paintings in the Vézère valley group, one other is now being explored in the Dordogne, viz., the cavern of La Mairie et Teyjat. This large cavern is only two hundred meters distant from the rock shelter of Mège, discovered in 1903 by M. Bourrinet. In the cavern of La Mairie the floor deposits may be separated into two industry-bearing layers. The upper one of these contains the same industry as the single layer in the adjacent rock shelter of Mège, except that the latter has furnished archeological material in greater quantities than were found in the deposits of the cavern. The relative positions of the engravings on the cavern walls and the upper layer of floor deposits prove that both belong to the same epoch (Magdalenian). It is also interesting to note that while bones of the reindeer abound in the rock shelter of Mège, representations of this animal pre-

dominate among the mural engravings in La Mairie cavern.

Besides the cavern of Chabot, at Aiguèze and of Pair-non-Pair, already mentioned, other decorated French caverns explored to date are: Le Figuier (Ardèche) across the river from Chabot, La Grèze and Marsoulas (Haute-Garonne).

Of caverns with paleolithic mural decorations outside of France, thus far reported, one is in Italy and four are in Spain. The most important cavern in the Spanish group is that of Altamira in the north coast province of Santander, previously mentioned as being the one in which the discovery of mural figures first took place. The genuineness of these figures would have continued to remain in doubt had it not been for similar subsequent discoveries elsewhere.

M. Émile Cartailhac and the Abbé H. Breuil have recently studied with great care the wall paintings and engravings at Altamira. The cavern is a series of large chambers connected by passageways. There is no evidence of its having been occupied by either man or beast since the close of the Quaternary, at which time the entrance was completely closed by a fall of earth and stones.

A second, recent fall has afforded a new opening to the cavern, reached by clambering over the débris that closed the original entrance. The first chamber is divided by means of a mass of fallen stones. The one on the left is forty meters long by twenty meters wide. The one on the right is a sort of corridor connecting with other chambers. Industrial remains of the floor deposits are confined to the entry and the chamber on the left. There is evidence that the cave bear had occupied the cavern before man took possession. Figures, engraved or painted, are found on the walls of every part of the cavern, especially on

the ceiling of the chamber on the left near the entrance, where the frescoes are remarkable for their beauty, size and good preservation—a sort of Sistine chapel representing the *chef d'œuvre* of perhaps more than one Michael Angelo of that far-off time.

These works of art represent a variety of technique. Some are simple line engravings. Others are more deeply incised. But the engravings are not so numerous as the figures represented in color. Many are done in a single color, either red or black. The most remarkable are the polychrome frescoes similar to those of Font-de-Gaume, already described.

The figures are not all animal representations. Many are signs, the significance of which is not known. They do not belong to a single epoch. The superposition of figures, each in a different technique, studied in connection with the relative state of preservation of the various figures has furnished a key to the order of succession. The same succession is traceable in the caverns of France, so that the Abbé Breuil and his colleagues: MM. Cartailhac, Capitan, Peyrony and Bourrinet, have been able to distinguish four distinct phases²² in the evolution of mural painting and engraving, all of them being represented in the cavern of Altamira.

The *first phase* includes deeply incised figures representing the animal in absolute profile, *i. e.*, with a single forefoot and a single hind foot, the outlines being rude and not well proportioned, and details, such as hoofs and hair, not indicated. The figure of a bison in the corridor on the right is a specimen of this oldest class of wall decoration. Other examples are found at La Grèze, Chabot and Pair-non-Pair.

The paintings of this stage are also in

²²A fifth and closing phase is discernible at Marsoulas, resembling somewhat the work on the painted pebbles of Mas d'Azil.

outline, the color being black or red and drawn with a crayon, there being absolutely no effort at modeling. The horse drawn in black on the ceiling of the left chamber is an illustration. Others may be seen at Marsoulas, Font-de-Gaume, La Mouthe, Combarelles and Bernifal.

The incised figures of the *second phase* remain deep and broad; but the outlines are more lifelike although often ill-proportioned. All four legs are often represented, the distal ones being almost completely hidden by those nearest the beholder. The hoofs are sometimes represented with great care. As the incisions become less deep they also gain in neatness. In places the effect of bas-relief is given by means of champlévé. The more hairy portions are indicated by incised lines. Engravings of this stage are not numerous at Altamira. They are seen to better advantage at La Mouthe, Font-de-Gaume, Bernifal and above all at Combarelles.

The paintings of this phase evince the first attempts at modeling by shading at various points. Engraving is often combined with the painting. The use of color continues to develop until one arrives at a monochrome silhouette usually in black. The contours are often heightened by engraving. The second phase is represented not only at Altamira, but also at Marsoulas, Combarelles, Font-de-Gaume and La Mouthe.

The engravings of the *third phase* are generally of small dimensions. Many of these are admirable in their execution, as, for example, the bison in the terminal corridor. The entire mural decorations in the cavern of La Mairie at Teyjat are in this style, as are a number from Font-de-Gaume and Marsoulas.

In the domain of painting, the third phase is represented by an excessive use of color, producing a flat effect, thus destroy-

ing the modeling that was such an attractive feature of the preceding stage. At Altamira the color employed is red and the drawing is deplorable. As a rule these examples are not well preserved. Those from Marsoulas, in either black or red, are not much better. The best work of this phase is to be seen at Font-de-Gaume and is executed in black or brown. It is often combined with engraving of a high order, done before the color was applied.

In the *fourth phase* the engravings lose their importance. The lines are broken and difficult to follow. The small figures of the mammoth at Font-de-Gaume and of the bison at Marsoulas show this tendency to emphasize detail at the expense of the ensemble.

Paleolithic painting reached its zenith in the fourth phase. The outlines are drawn in black, as are the eyes, horns, mane and hoofs. The modeling is done with various shades produced by the mixing of yellow, red and black. Engraving always accompanies the fresco, serving to emphasize the details. These polychrome figures are seen at their best on the ceiling of the left chamber near the entrance; also at Marsoulas and Font-de-Gaume.

Shortly before his death, M. P. Jamin, a well-known Parisian artist, exhibited in the Paris Salon of 1903 a large oil painting inspired by the discovery of these polychrome frescoes. This canvas also formed part of the French art exhibit at the Louisiana Purchase Exposition, St. Louis, in 1904. It represents the cave-dweller artist in the little side chamber of Font-de-Gaume at work on one of the thirteen figures of the bison while members of his family look on and applaud. In a panel above his head is the unfinished group of reindeer. It has long been the custom for artists to copy the old masters. M. Jamin has rendered a valuable service to both art

and archeology by introducing the modern French school of painters to the earliest school of art developed on what is now French soil. The ages of Phidias and of the Italian Renaissance, viewed in the light of their antecedents, are wonderful manifestations; but not more wonderful than that of the Vézère troglodyte, a contemporary of the mammoth and rhinoceros, the bison and the reindeer.

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FOR several years the biological chemists of this country have been considering the advisability of organizing a national biochemical society. The growth of the Society of Physiological Chemists (New York City), which was founded in 1899, the development of the biochemical section of the American Chemical Society, which was organized in 1905, the increasing number of chemical papers on the programs of the American Physiological Society, and the great success of the recently established *Journal of Biological Chemistry*, were among the influences that stimulated thoughts of a national organization of biochemical workers.

At the suggestion of Professor John J. Abel, a meeting for the purpose of effecting the establishment of such a society was held in New York City, at the headquarters of the American Association for the Advancement of Science (Hotel Belmont), on the afternoon of December 26, 1906. About seventy-five American biological chemists had been invited by Professor Abel to attend the meeting, but many were unable to go to New York at the time stated. There were few, however, who did not heartily favor the project. Of those who had been invited to attend the meeting the following were present: